Electromagnetic Calorimetry Production and Assembly

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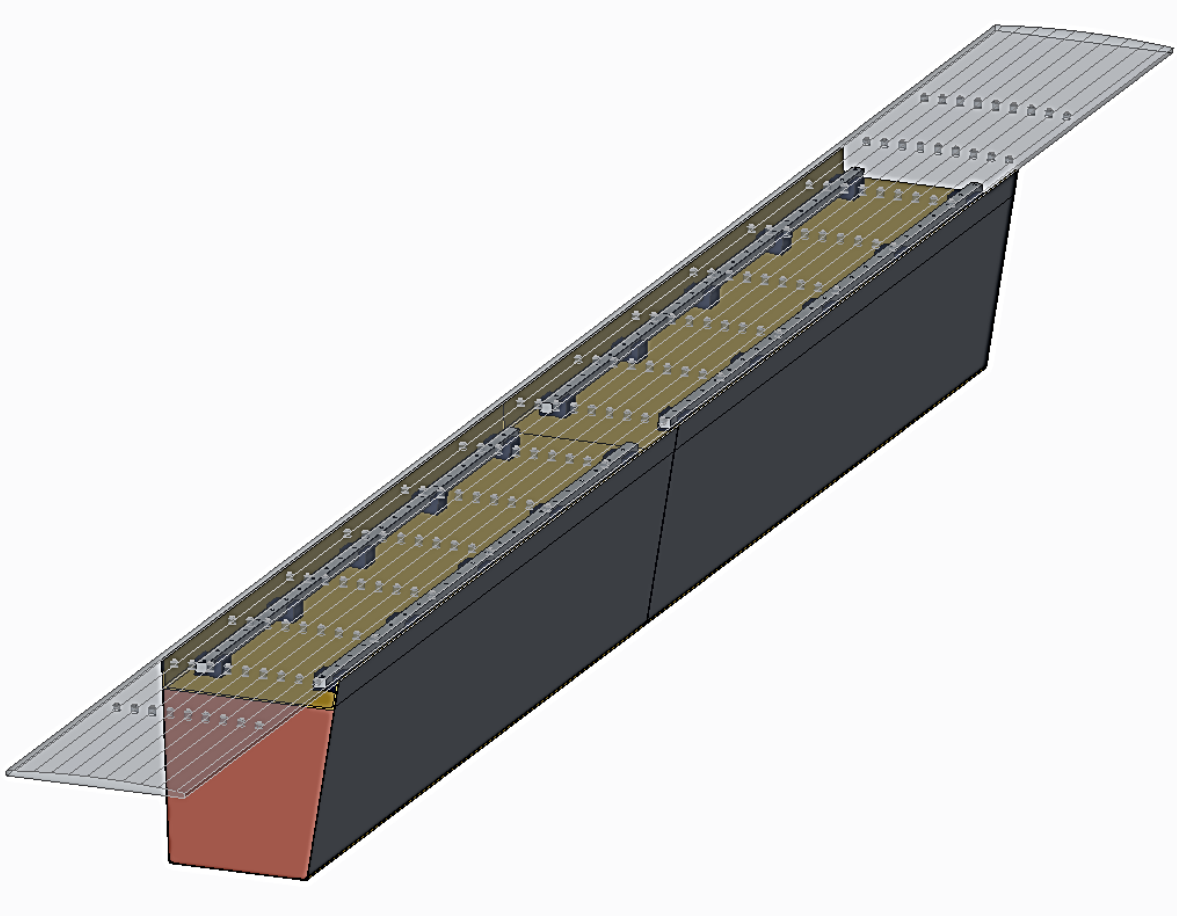
Topics

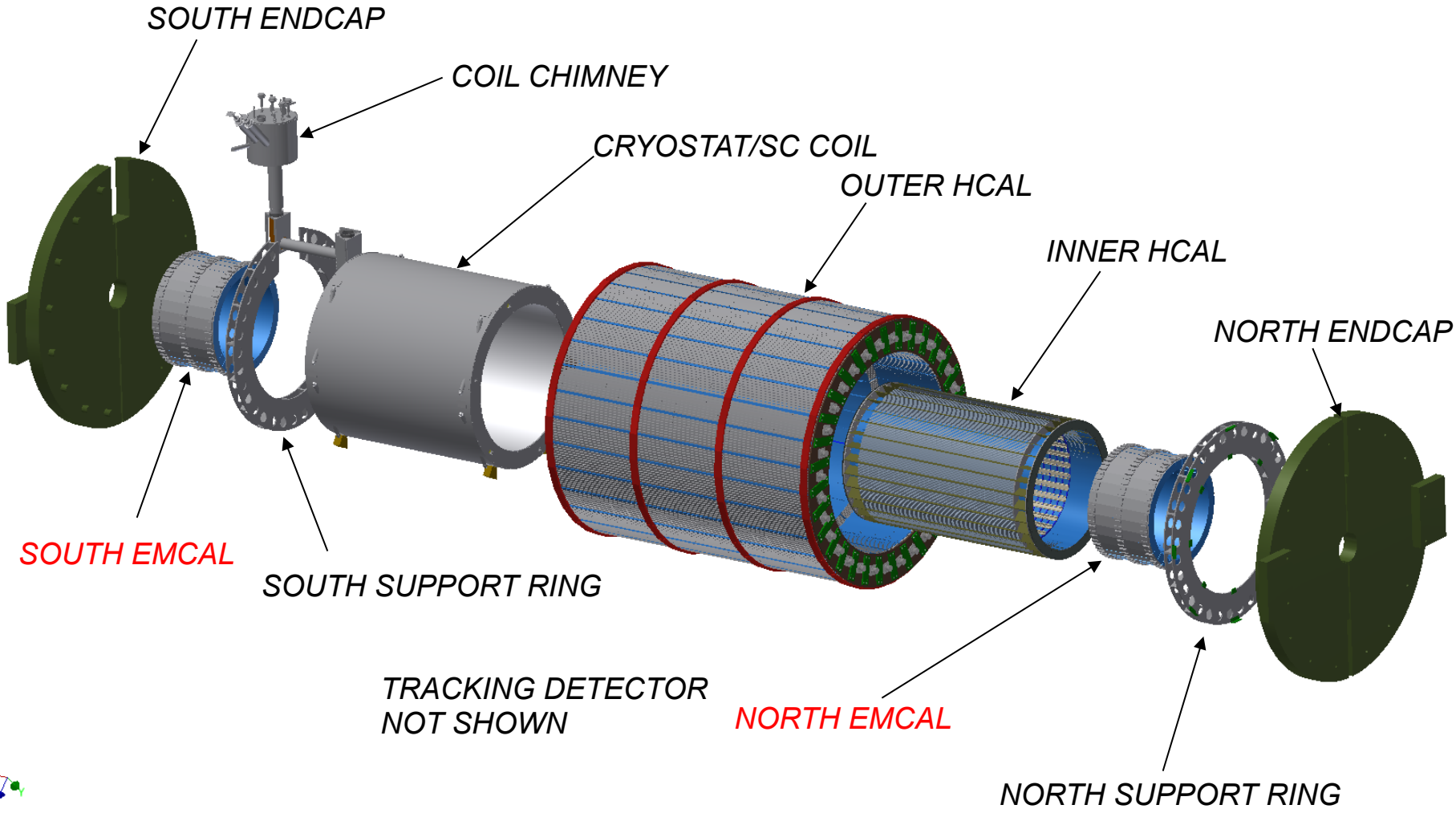
- Technical requirements
- EMCal overview
- Mechanical layout
- Absorbers
- Structure
- Cooling
- Assembly
- Cost & schedule drivers
- Schedule summary
- Issues and concerns



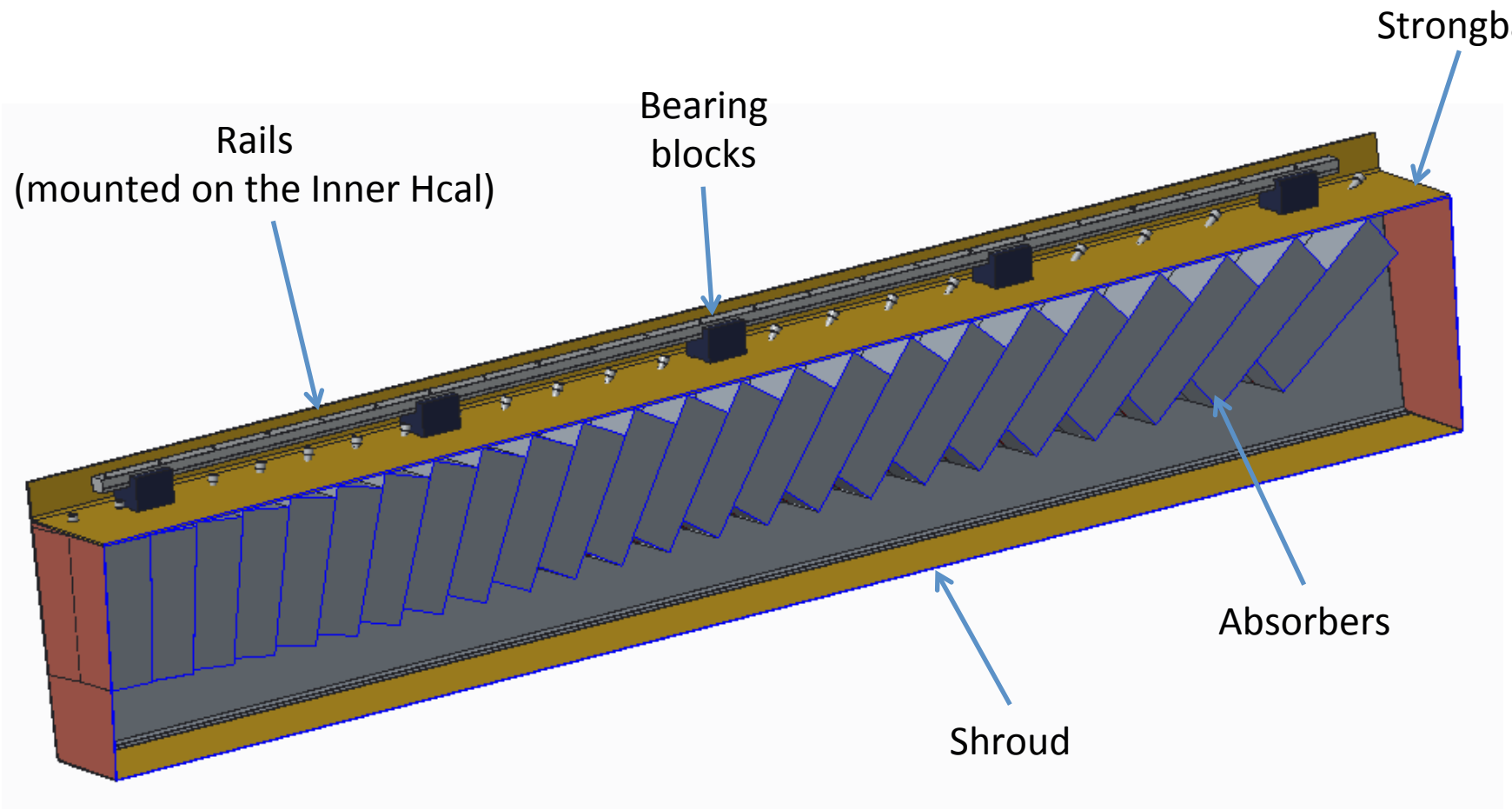
Technical Requirements

- Minimize gaps, deflections and dead spaces
- Minimize machining of towers
- Independently removable sectors
- Cooling required for SiPMs and electronics
- Fit inside BaBar magnet
  - ID = 1800 mm, OD = 2322, Length = 2990
- Supported by the inner HCal

sPHENIX Exploded View, EMCal Location

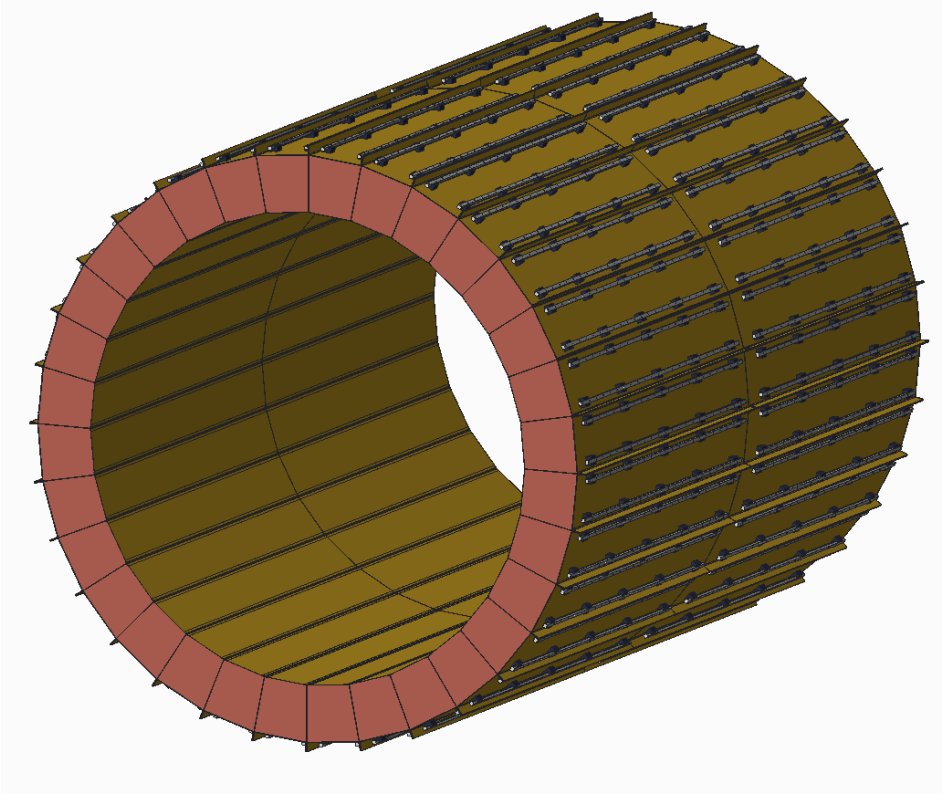


Sector Section



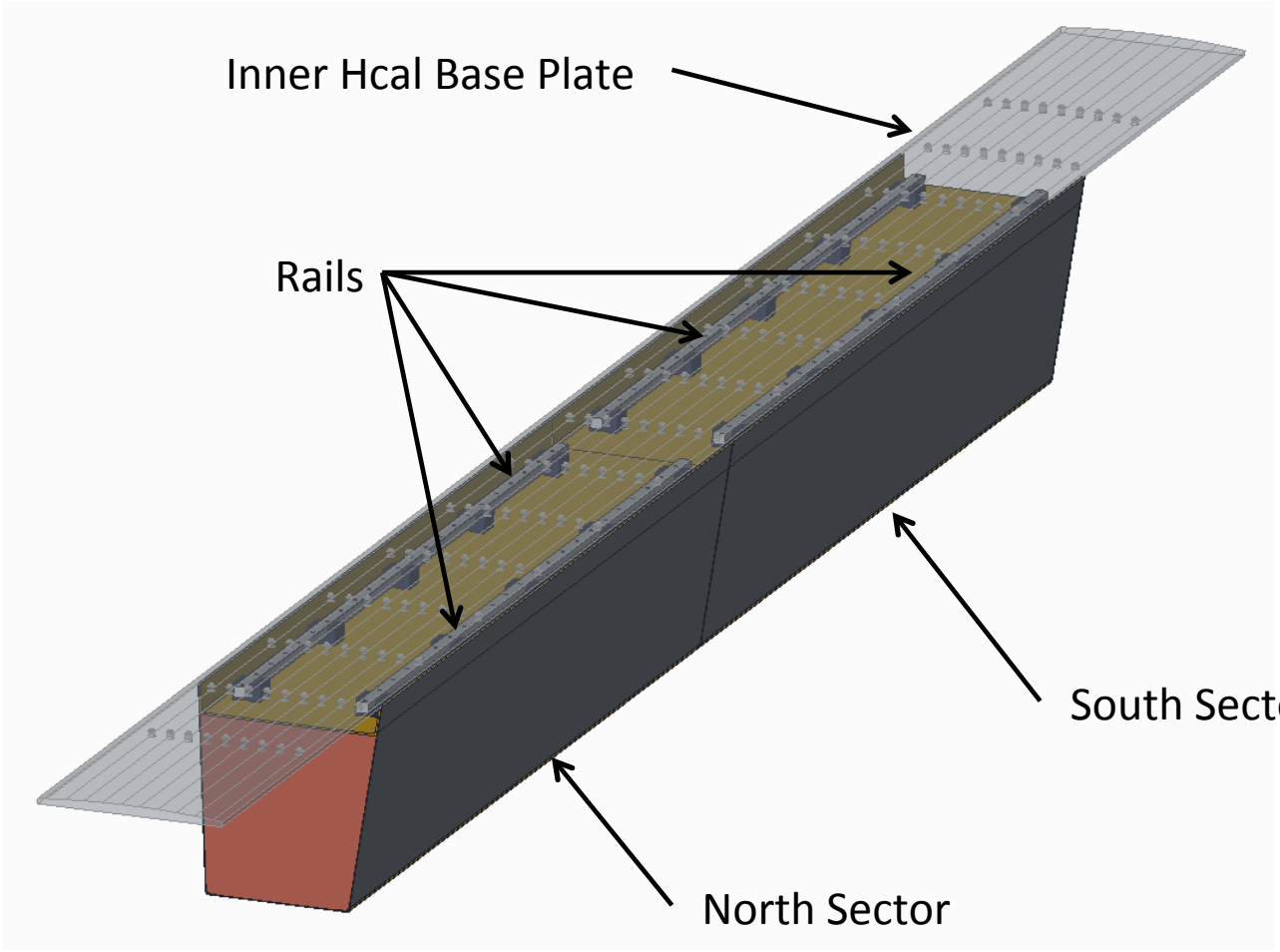
64 sectors required to build EMCal

North & South EMCal



- 32 North sectors
- 32 South sectors
- 2 Rails each
- ~300 cm overall length
- ~232 cm outer diameter
- ~180 cm inner diameter

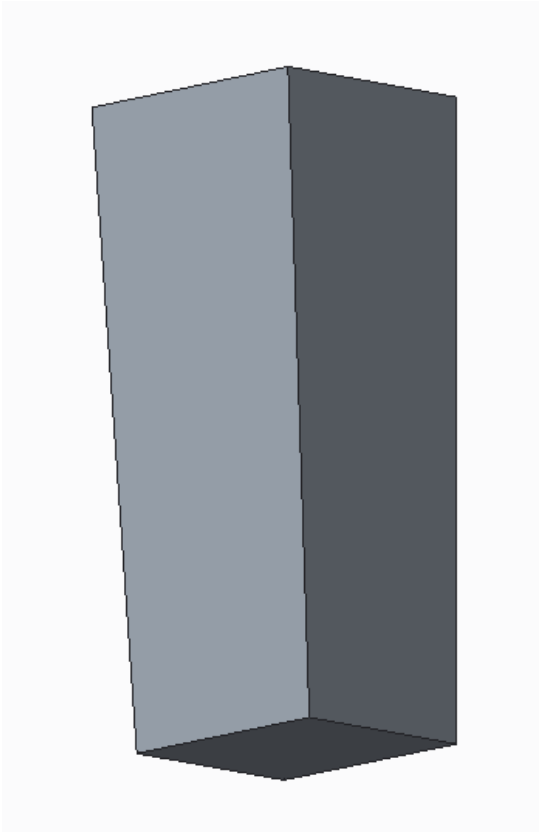
EMCal / Inner Hcal Mounting



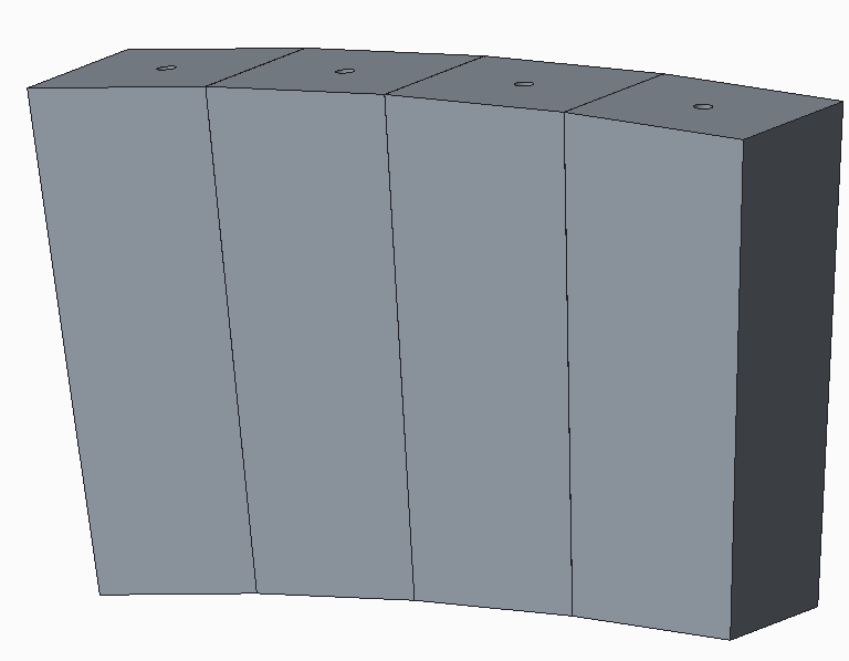
Absorber Block Layout

- 4 towers (2x2) = 1 block
- 4 blocks (2x8) = 1 module (row)
- 24 modules (48x8) = 1 sector
- 2x 32 sectors = 1 EMCal
- 24,576 towers = 1 EMCal

1 Block



1 Module (bonded with epoxy)



Absorber Building Blocks

Sector Construction

- Each block is molded and machined
- 1 mold shape per row
- 4 blocks are epoxied together and machined to form a module
- 24 modules are mechanically fastened to the EMCal strongback

Block Shape

- Geometrically driven from EMCal shape & radial particle path from center
- Minimize gaps
- 135 mm minimum length

Structure and load Path

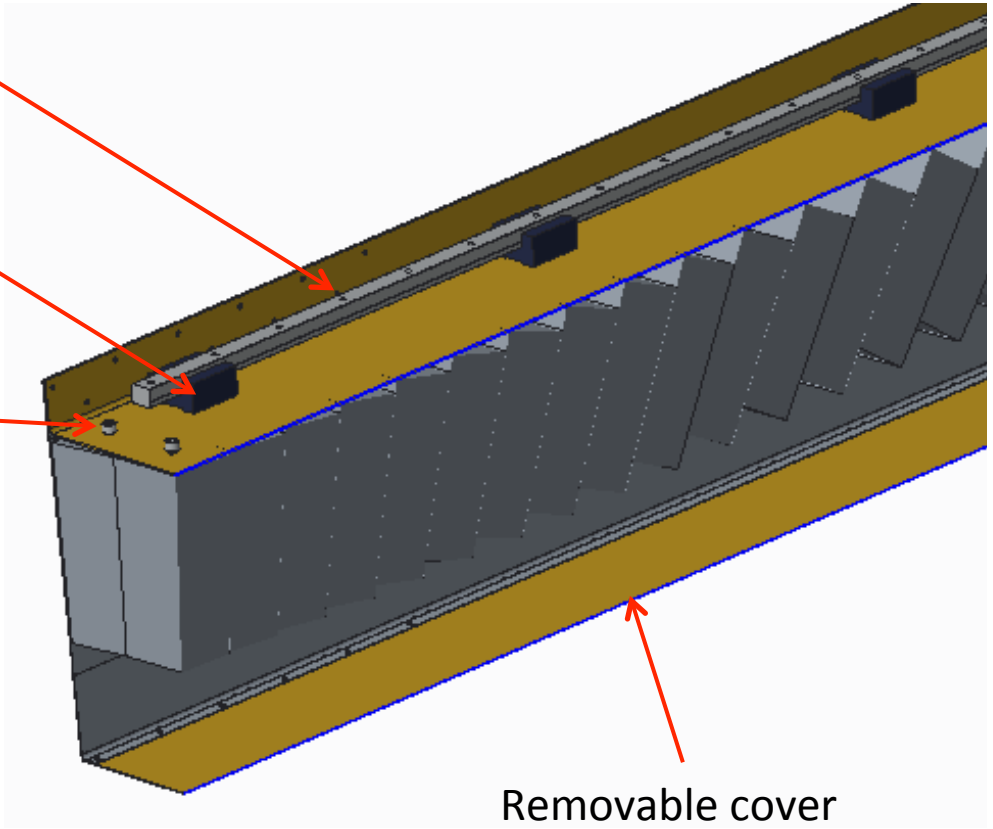
- Stiffness is key!
- Each sector weighs 950 lbf
- 3 & 9 o'clock positions have the most deflection
- EMCal sectors are attached to the inner HCal
- HCal interface precision contributes to gap size
- Sectors need the ability to be independently removed from any position for maintenance

Sector Load Path

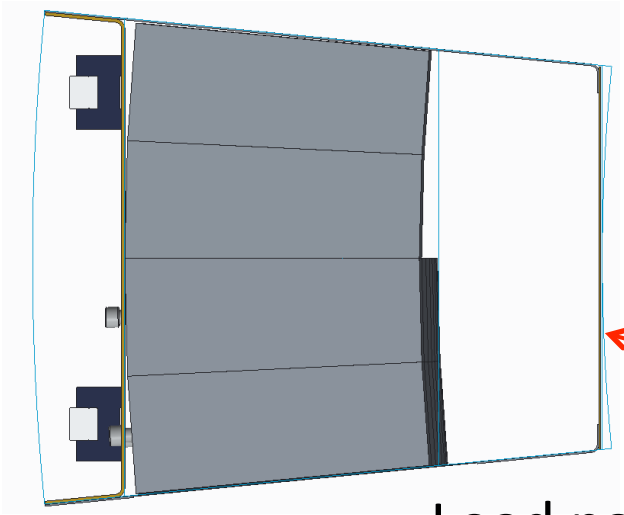
Rails are bolted to inner HCal

Multiple bearing blocks are bolted to the strongback

Each module is bolted to the stainless steel strongback



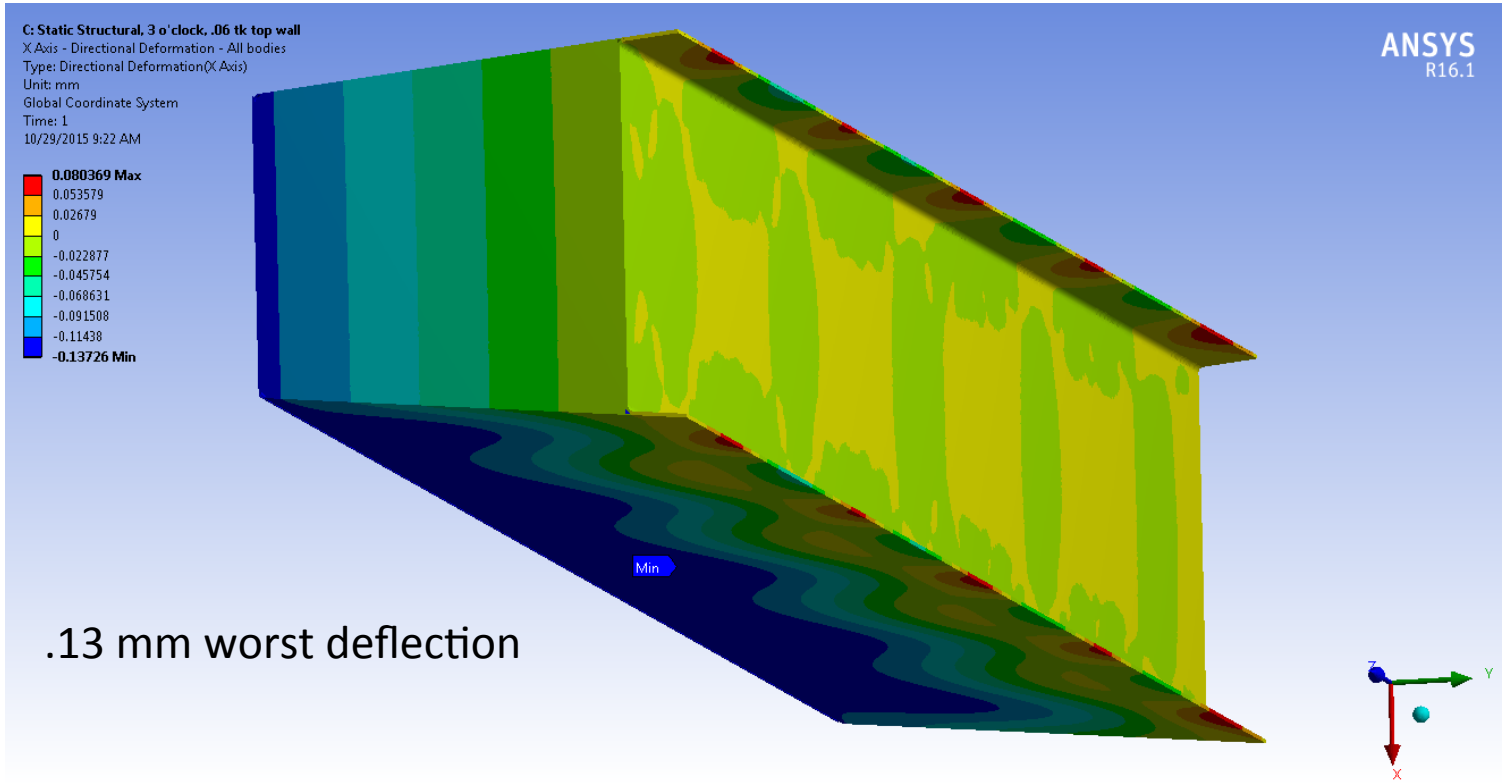
Removable cover for in-situ access



Sheet metal shroud & end covers (not shown) are not part of the structural load path

Load path from modules to HCal is direct!

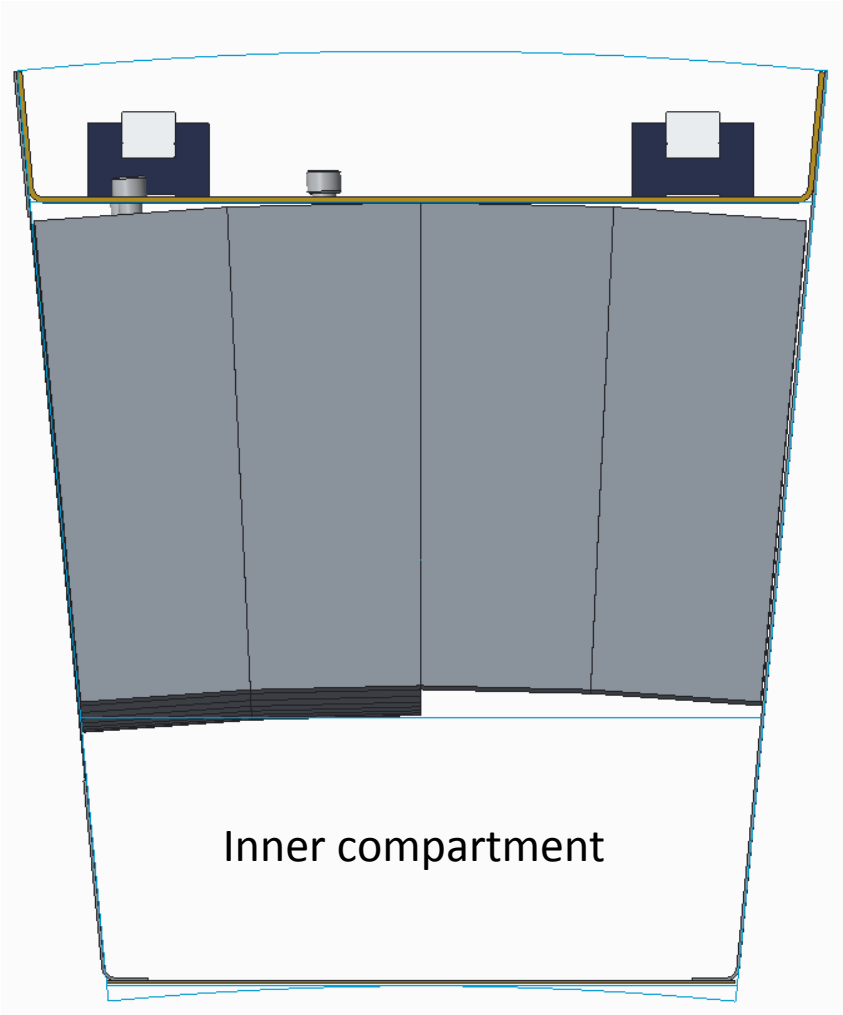
Preliminary EMCal Shroud Deflection
Worst Case, 3 o'clock



- Bearing block and Inner Hcal contributions not included
- 24 individual mass modules connected to strongback

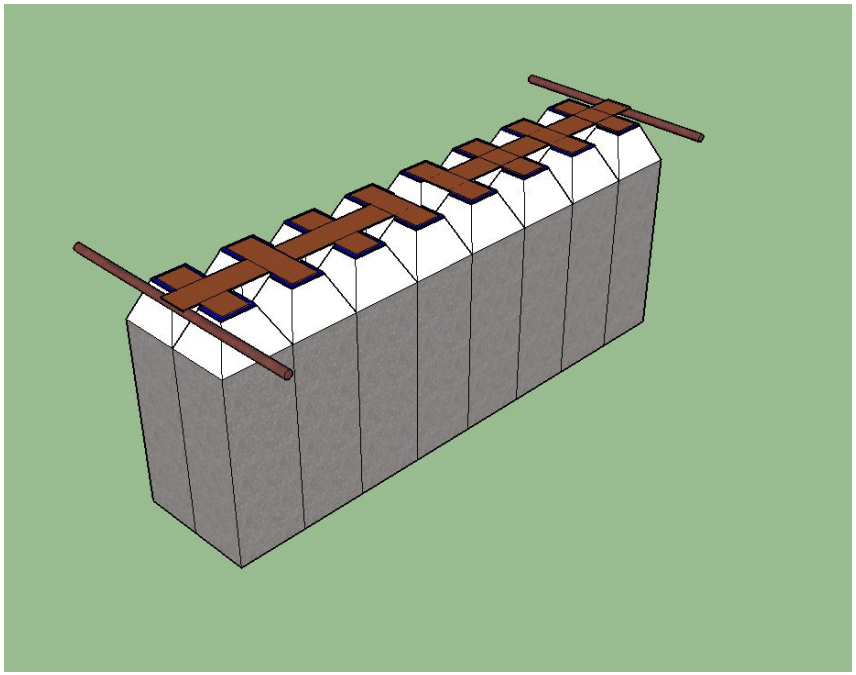
Inner Compartment

- Houses light guides, front end electronics & cables
- Cooling is required for the SIPMs and electronics
- All penetrations are from external end of EMCal



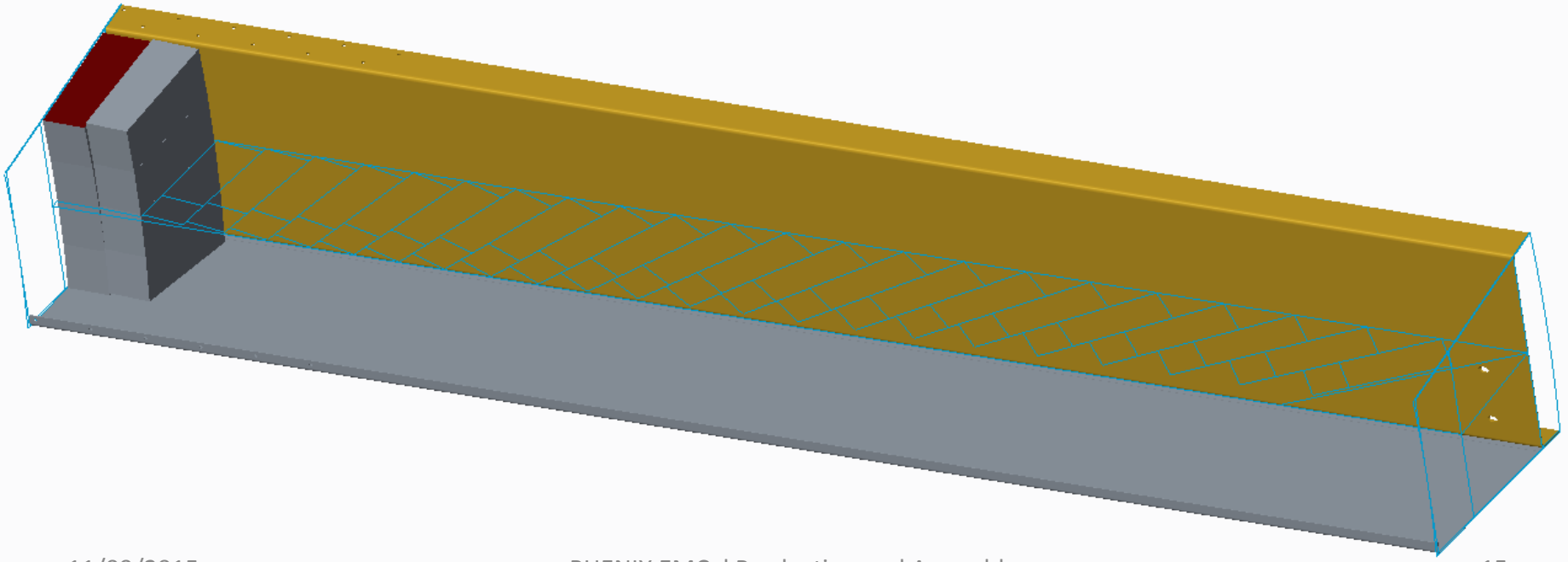
Cooling

- SiPMs and electronics require cooling and possibly temperature stabilization
- 100 Watts per sector
  - 6,400 W total for entire EMCal
- Closed loop, liquid cooling



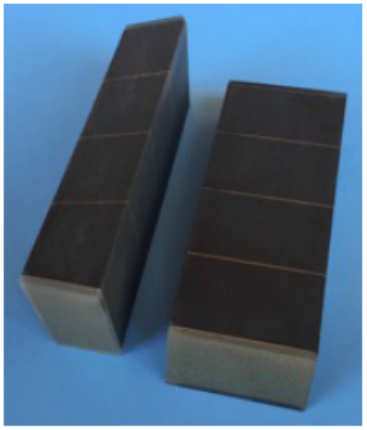
Assembly

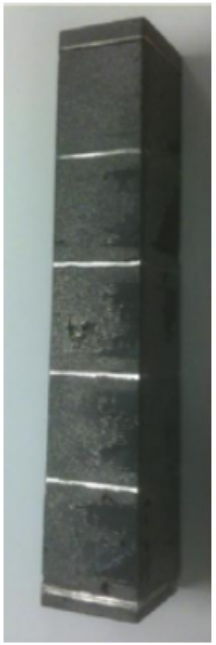
- Assembled on side
- Assembled in a stress free state
- Add support aft of last module
- Attach remaining shroud skins
- Assembled at University of Illinois



schedule drivers

- R&D on 2D projective design
  - 1D projective modules (2x1 towers) have been successfully produced at UCLA, Tungsten Heavy Powder (industry), Illinois and BNL
    - production process well under control
  - 2D projective production process being developed
    - 2D projective blocks (1x1 tower) have been produced at BNL and Illinois
    - goal: 2D projective modules for v2 prototype (10/16) with a production process that will scale to full detector
    - want to make blocks bigger than 1x1 tower





cost/schedule drivers

- assembly/testing of sectors
  - large number of towers/SiPMs
  - current schedule based on university based module production assembly and testing
  - pursuing alternate industry based module production (THP), university based assembly and testing
    - understand feasibility of both module production options
      - unclear how industry module production affects cost—this will be more clear after prototyping process

EMCal schedule summary

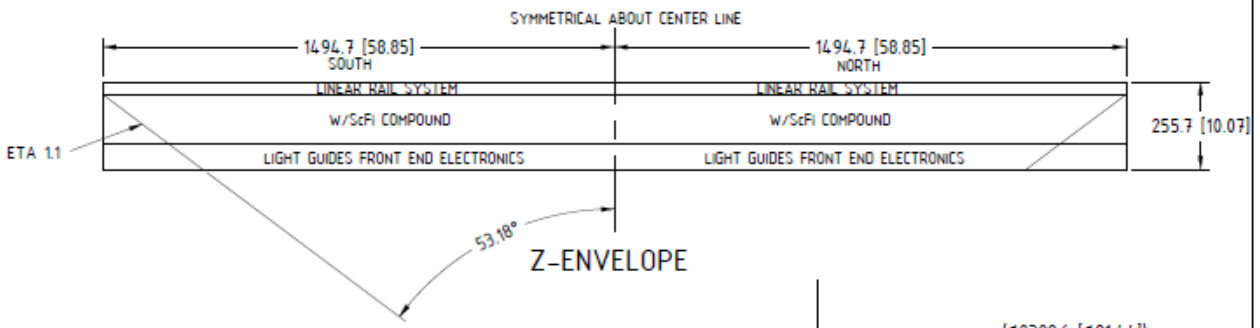
v1 prototype	ongoing-Apr '16
v2 prototype	Mar '16- May '17
preproduction prototypeprototype	May '17 - Jun '18
design	Apr '16 - Oct '17
module production	Jun '18 - Sep '20
supermodule assembly	Jun '18 - Sep '20
ready for detector installation	Sep '20

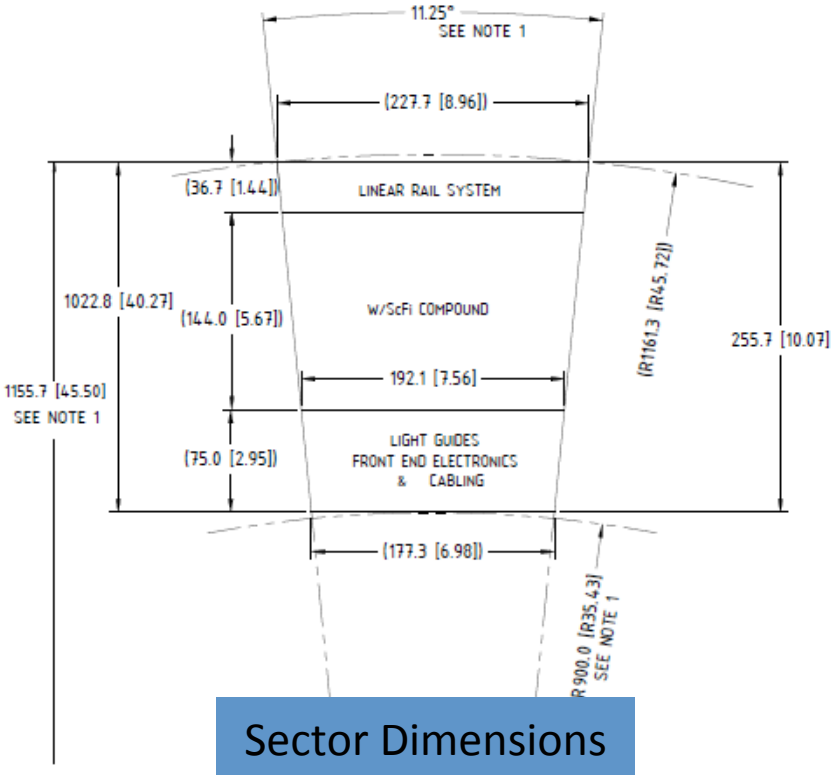
Issues & Concerns

- The cooling scheme has not been incorporated. The possible requirement for SiPM temperature stability will drive the detailed cooling design.
- The packaging of the cables and electronics in the inner compartment has not been performed
- Fabrication and assembly tolerances and installed deflection will influence gaps and dead areas
- Absorber Projectivity, 1 or 2 D

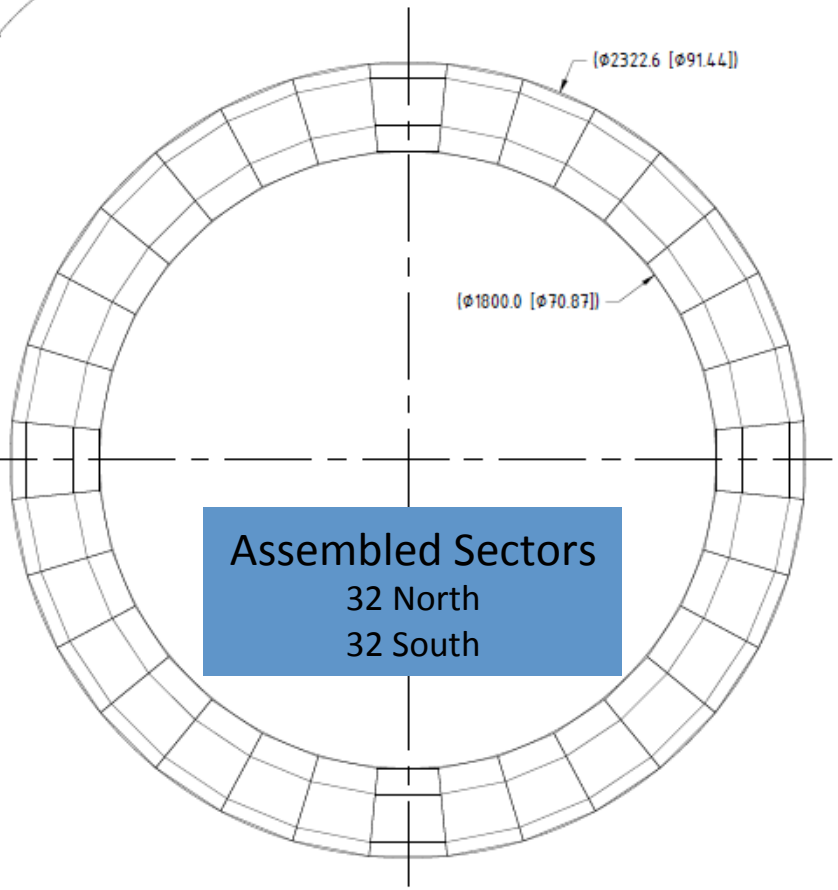
Backup

NOTES:
1. NOTED DIMENSIONS ARE MAXIMUM SIZE.
   ALL SERVICES, NUTS, BOLTS & OTHER DETECTOR
   COMPONENTS SHALL NOT EXCEED THESE DIMENSIONS.
2. ALL DIMENSIONS ARE IN mm[inch].





Sector Dimensions



Assembled Sectors
32 North
32 South

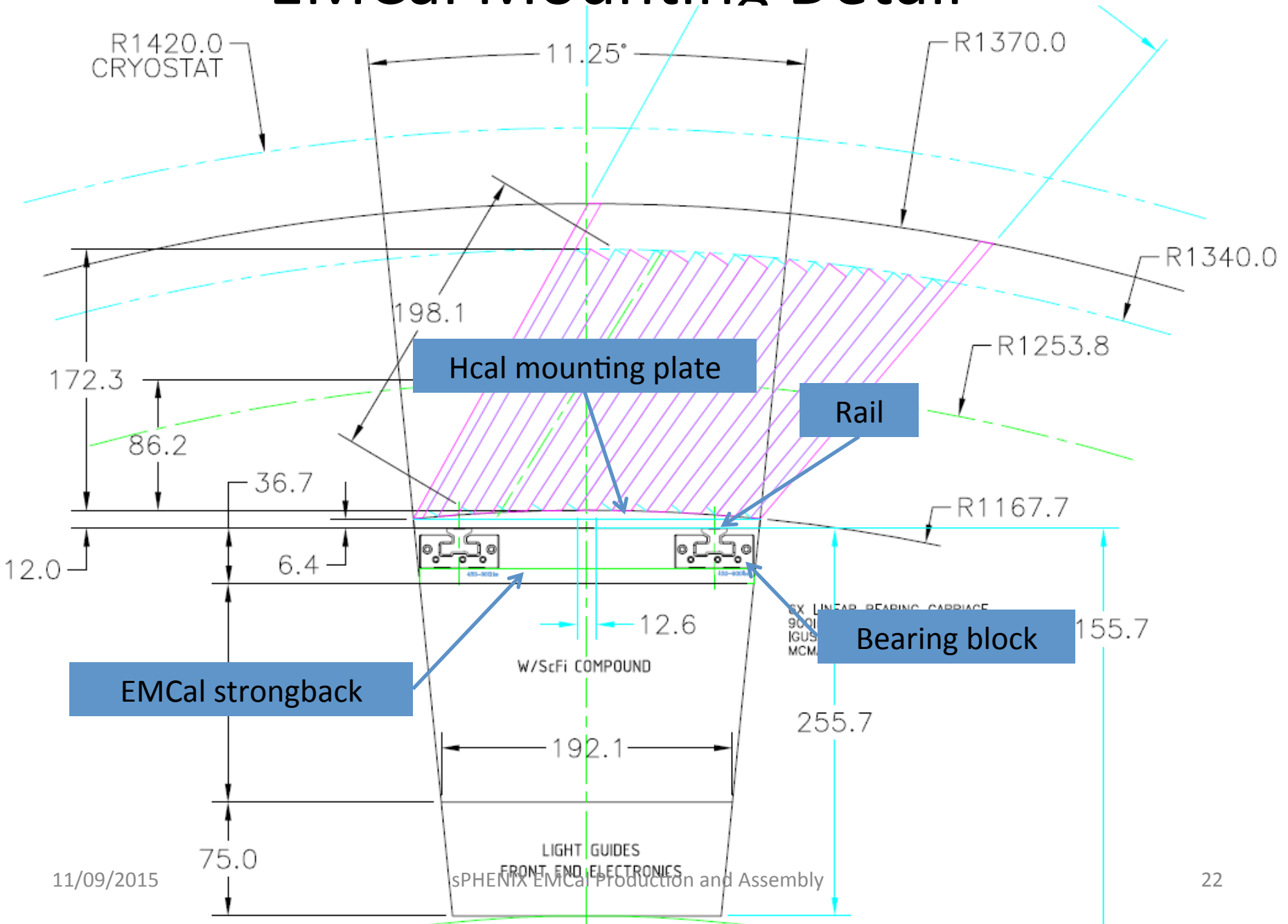
PRELIMINARY
3/26/2015

BROOKHAVEN NATIONAL LABORATORY
Upton, NY 11973

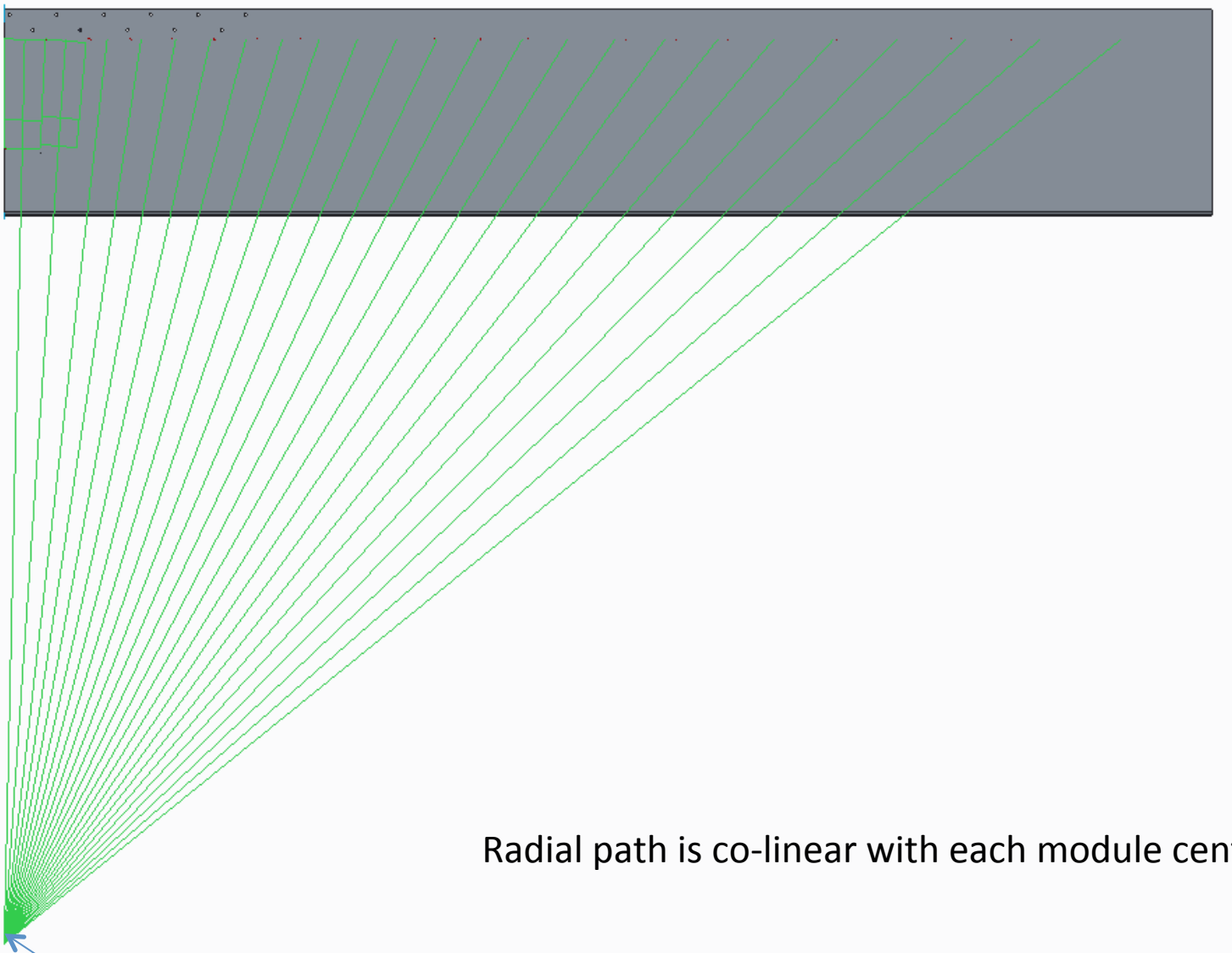
PHENIX
sPhenix
EMcal Module Envelope

SP00-0002004

EMCal Mounting Detail



Block Shape Origin



Radial path is co-linear with each module centerline

Intersection Point